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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
08/825,360	03/28/1997	MARVIN LIAO	761/P7US/CVD	9780

7590 10/29/2003

SUPERVISOR, PATENT PROSECUTION SERVICES
PPIER RUDNICK LLP
1200 NINETEENTH STREET, NW
WASHINGTON, DC 20036-2412

EXAMINER

QUACH, TUAN N

ART UNIT	PAPER NUMBER
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2814

DATE MAILED: 10/29/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application N .	Applicant(s)	
	08/825,360	LIAO ET AL.	
	Examiner	Art Unit	
	Tuan Quach	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 September 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 54-80 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 54-80 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 27 March 1997 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>0902</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claims 55, 63, 72 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 55, the ending period is missing; in claim 63, "the biasing step" lacks antecedent basis; in claim 72, "the metal nitride" lacks antecedent basis.

Claims 69-80 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. There is no support for the interconnect for gate widths of the dimensional range now claimed in claim 75. Applicant is requested to point out support for the particular dimension now claimed in the preamble of claim 75. The specification on page 7 line 18 appears to refer to .25 μm . There is no support for the first layer being tungsten as now claimed in claim 70; there is no support for the refractory metal to include tungsten as now claimed in claim 69. Applicant is requested to point out support from the original disclosure for the use of tungsten as the particular material for the first layer. The specification on page 13, lines 4-5 recites that the first material may be a generic refractory metal and recites titanium, cobalt, tantalum, and molybdenum but does not recite the particular material of tungsten and the particular combination now claimed.

This application presents a claim for subject matter not originally claimed or embraced in the statement of the invention. The various additionally claimed matter regarding the collimator, e.g., claim 76, the ionization coil, e.g., claim 77, the particular material of tungsten as the first layer material, e.g., claim 69, 70. A supplemental oath or declaration is required under 37 CFR 1.67. The new oath or declaration must properly identify the application of which it is to form a part, preferably by application number and filing date in the body of the oath or declaration. See MPEP §§ 602.01 and 602.02.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

For convenient referencing, "et al." are omitted, e.g., Bai for Bai et al.

Claims 54-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Ho, Hower, or Fu, and Harshfield.

Bai (5,714,418) teaches forming substrate 40, forming dielectric 41, patterning the dielectric layer 40 to form trench 47, forming capturing layer 43 of titanium material having a thickness between 5 Å and 500 Å, forming blocking layer of titanium nitride having a thickness between 10 Å and 500 Å. Deposition by sputtering or by CVD is also taught. See column 5 lines 1-33, column 8 lines 7-57, Fig. 3, column 10, lines 4-49.

Bai lacks anticipation essentially in that it does not explicitly recite the plasma annealing of the titanium nitride barrier.

Ho (5,175,126) teaches plasma reaction of titanium nitride in suitable gases, e.g., oxygen, nitrogen, to fill the grain boundaries hence improving barrier characteristics. See column 7 line 28 to column 8. The use of nitrogen or hydrogen as the gas to stuff the nitride is also taught. See column 7 lines 4-27, column 10 lines 3-20.

Hower (5,712,193) teaches plasma treatment of titanium nitride in argon to reduce silicon movement therethrough and to reduce interface defects. See column 2 line 56 to column 3 line 30.

Fu (5,685,960) teaches plasma treatment of titanium nitride in argon wherein the treatment smoothens the TiN and improves wettability. See column 2 line 48 to column 3 line 16.

Harshfield (5,612,558) teaches forming refractory metal nitride 50 including by CVD using TDMAT having excellent conformity and the plasma annealing including in hydrogen or nitrogen is advantageous wherein organic content including carbon can be

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reduced and wherein lower resistance can be obtained. See column 4 line 29 to column 5 line 18.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the Bai process to have employed plasma treatment of the titanium nitride since such is conventional and advantageous to improve barrier characteristics and wettability as taught by Ho, Hower, and Fu. Such annealing of the titanium nitride would have been further advantageous since it would permit the titanium nitride to have improved characteristics including lower resistance and reducing organic or carbon content as taught by Harshield. It would have been obvious and would have been within the purview of one skilled in the art to have employed conventional collimating sputtering including conventional use of ionization coil for such sputtering, to have selected the desired conventional plasmas, the conventional electrical biasing, and rf signal, to have employed conventional alternative refractory metal such as titanium, tungsten, tantalum, cobalt, molybdenum, and conventional alternative metal nitrides, including the optimization of appropriate layer thicknesses including the teachings as delineated in Bai as delineated above, including at column 10 lines 11-15, lines 48-50, lines 56-62. The plasma annealing in the same chamber or in a different chamber would have been obvious and would correspond to an obvious alternative wherein exposure to air and contamination therefrom can be avoided. Alternatively, official notice is given regarding such conventional collimating sputtering, conventional use of ionization coil during sputtering, conventional plasmas, electrical biasing and rf signal, same chamber treatment, conventional alternative refractory metal or metal nitrides.

The use of sputtering and CVD would have been conventional and obvious to form the layers in question and as such use of CVD of TiN including the use of metalorganic gas, e.g., as in claims 54, 65, 71, 79, 80 is advantageous to provide conformity as evidenced by Harshfield. Regarding the use of plasma of at least one gas of nitrogen, hydrogen, argon, helium, or ammonia, e.g., as in claims 58, 60, 67, the selection of such conventional and appropriate plasma would have been obvious given the plasmas employed in Ho, Hower, Fu, and Harshfield as delineated above.

Claims 58, 61-63, 66-67, 73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Ho, Hower, or Fu, and Harshfield as applied to claims 54-80 above, and further in view of Gilboa.

Regarding the limitations in these claims, Gilboa (EP 0 477 990) further evidences the conventionality of using appropriate plasma annealing ambient including ammonia, and the plasma treatment using the same chamber or a different chamber wherein exposure to air can be avoided, and the biasing during plasma treatment and the optimization of processing parameters to obtain optimal enhancement of a particular barrier film, see, e.g., column 4 line 33 to column 5 line 32.

It would have been further obvious to one skilled in the art to have employed such alternative plasma environment, alternative of using same chamber or different chamber, and the use of bias during plasma treatment since such use is conventional and advantageous as suggested by Gilboa.

Claims 54-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit or Sandhu taken with Suguro, Harshfield, and Ho or Fu.

Dixit (4,960,732) teaches forming channel 16 through insulating layer 14, forming titanium 19, e.g., about 100 Å, forming titanium nitride thereon, e.g., to about 250 Å, using conventional deposition method. Well known alternative refractory metals and metal nitrides and alternative deposition techniques are also shown. See column 4 line 64 to column 7 line 11.

Sandhu (5,723,382) teaches channels 31 in insulating layer 32, forming titanium layer 35, forming titanium nitride barrier layer 4, forming tungsten or aluminum or copper thereon. See column 6 line 61 to column 7 line 33.

The Suguro article teaches the use of TiN as barrier layer wherein optimization of layer thickness of the titanium nitride is also taught, including the use of TiN thickness of 4 nm, 7 nm, and 10 nm; see the abstract, the paragraph bridging pages 280 and 281, wherein TiN thickness as low as 10 nm is employed.

Harshfield (5,612,558) teaches forming refractory metal nitride 50 including by CVD using TDMAT having excellent conformity and the plasma annealing including in hydrogen or nitrogen is advantageous wherein organic content including carbon can be reduced and wherein lower resistance can be obtained. See column 4 line 29 to column 5 line 18.

It would have been obvious to one skilled in the art at the time the invention was made in practicing Dixit or Sandhu to have employed plasma treatment of the titanium nitride since such is conventional and advantageous since it would permit the titanium nitride to have improved characteristics including lower resistance and reducing organic or carbon content as taught by Harshfield. It would have been obvious and would have

been within the purview of one skilled in the art to have employed conventional collimating sputtering including conventional use of ionization coil for such sputtering, to have selected the desired conventional plasmas, the conventional electrical biasing, and rf signal, to have employed conventional alternative refractory metal such as titanium, tungsten, tantalum, cobalt, molybdenum, and conventional alternative metal nitrides, including the optimization of appropriate layer thicknesses including the teachings as delineated in Sugaro and Dixit as delineated above. Alternatively, official notice is given regarding such conventional collimating sputtering, conventional use of ionization coil during sputtering, conventional plasmas, electrical biasing and rf signal, same chamber, conventional alternative refractory metal or metal nitrides. The use of sputtering and CVD would have been conventional and obvious to form the layers in question and as such use of CVD of TiN including the use of metalorganic gas, e.g., as in claims 54, 65, 71, 79, 80 is advantageous to provide conformity as evidenced by Harshfield and as evidenced by Sandhu, the abstract, column 2 lines 55-65. Regarding the use of plasma of at least one gas of nitrogen, hydrogen, argon, helium, or ammonia, e.g., as in claims 58, 60, 67, the selection of such conventional and appropriate plasma would have been obvious as delineated above and as delineated in Sandhu, column 5 line 63 to column 6 line 7 and in Fu evidencing the conventionality of appropriate plasmas. Alternatively, official notice is given regarding the selection of the desired and conventional plasmas. The use of first and second plasma to insure effectiveness of such treatment would have been obvious as shown in Ho as delineated above.

Claims 58, 61-63, 66-67, 73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit or Sandhu taken with Suguro, Harshfield, and Ho or Fu as applied to claims 54-80 above, and further in view of Gilboa.

Regarding the limitations in these claims, Gilboa (EP 0 477 990) further evidences the conventionality of using appropriate plasma annealing ambient including ammonia, and the plasma treatment using the same chamber or a different chamber wherein exposure to air can be avoided, and the biasing during plasma treatment and the optimization of processing parameters to obtain optimal enhancement of a particular barrier film, see, e.g., column 4 line 33 to column 5 line 32.

It would have been further obvious to one skilled in the art to have employed such alternative plasma environment, alternative of using same chamber or different chamber, and the use of bias during plasma treatment since such use is conventional and advantageous as suggested by Gilboa.

Claim 77 is rejected under 35 U.S.C. 103(a) as being unpatentable over *** as applied to claims 54-80 above, and further in view of Kniseley.

The use of ionization coil for thin film coating as in this claim is well known in the art as delineated above and as evidenced by Kniseley, column 6 lines 54 to column 7 line 3 and as such would have been obvious.

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 54-80 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-41 of U.S. Patent No. 5,989,999 (hereinafter '999) in view of any of Dixit, Sandhu, or Suguro.

'999 claims the deposition of tantalum nitride and plasma treatment annealing, e.g., claim 1, including by metallorganic precursor gas (claim 14); the plasma environment (claims 1, 34) also is taught including nitrogen, hydrogen, argon, helium, ammonia, e.g., claim 10. The use of biasing, first and second plasma, same chamber, etc., is also claimed. The carbon reduction would take place during such plasma exposure since the same plasma processing is employed; such and further is conventional, inherent and apparent as evidenced by '999, see, e.g., column 22 lines 43-45. This thus corresponds substantially to the claimed subject matter in the claims of the instant application (S.N. 08/825,360; hereinafter '360) except for the use of an underlying refractory metal.

Dixit, Sandhu, and Suguro are applied as above.

It would have been obvious to one skilled in the art in practicing the above claimed invention to have included the underlying refractory metal since such use is conventional and advantageous to improve adhesion and to reduce resistivity as delineated in Dixit, column 4 line 20 to column 5 line 13, particularly column 4 lines 20-

37 wherein such underlying layer is conventional and advantageously serves as an adhesion layer and to reduce resistivity; as in Sandhu, column 6 line 61 to column 7 line 25 wherein the underlying titanium metal 35 serves to provide a low-resistance interface at the surface of the diffusion region; as in Suguro, the abstract, Fig.4, pages 280-281. It would have been obvious to one skilled in the art to have employed alternative and interchangeable metal nitrides given the teachings of Dixit, column 4 lines 43 et seq., and as evidenced from the record, including, e.g., previously enumerated in now cancelled claims 9, 20, 28, 50. The employment and optimization of appropriate layer thickness would have been obvious and would have been within the purview of one skilled in the art, given the teachings of Dixit, column 4 lines 28-57, of Suguro, wherein optimization of layer thickness of the titanium nitride is also taught, including the use of TiN thickness of 4 nm, 7 nm, and 10 nm; see the abstract, the paragraph bridging pages 280 and 281, wherein TiN thickness as low as 10 nm is employed.

Applicant's arguments with respect to claims 54-80 have been considered but are moot in view of the new ground(s) of rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is 703-308-1096. The examiner can normally be reached on M - F from 9 to 5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Wael Fahmy can be reached on (703) 308-4918. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9318 (Before Final) and (703) 872-9319 (After Final).

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Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

A handwritten signature, possibly reading "TH", is located in the lower right quadrant of the page.